

March 15, 1966

P. VON WIESENTHAL

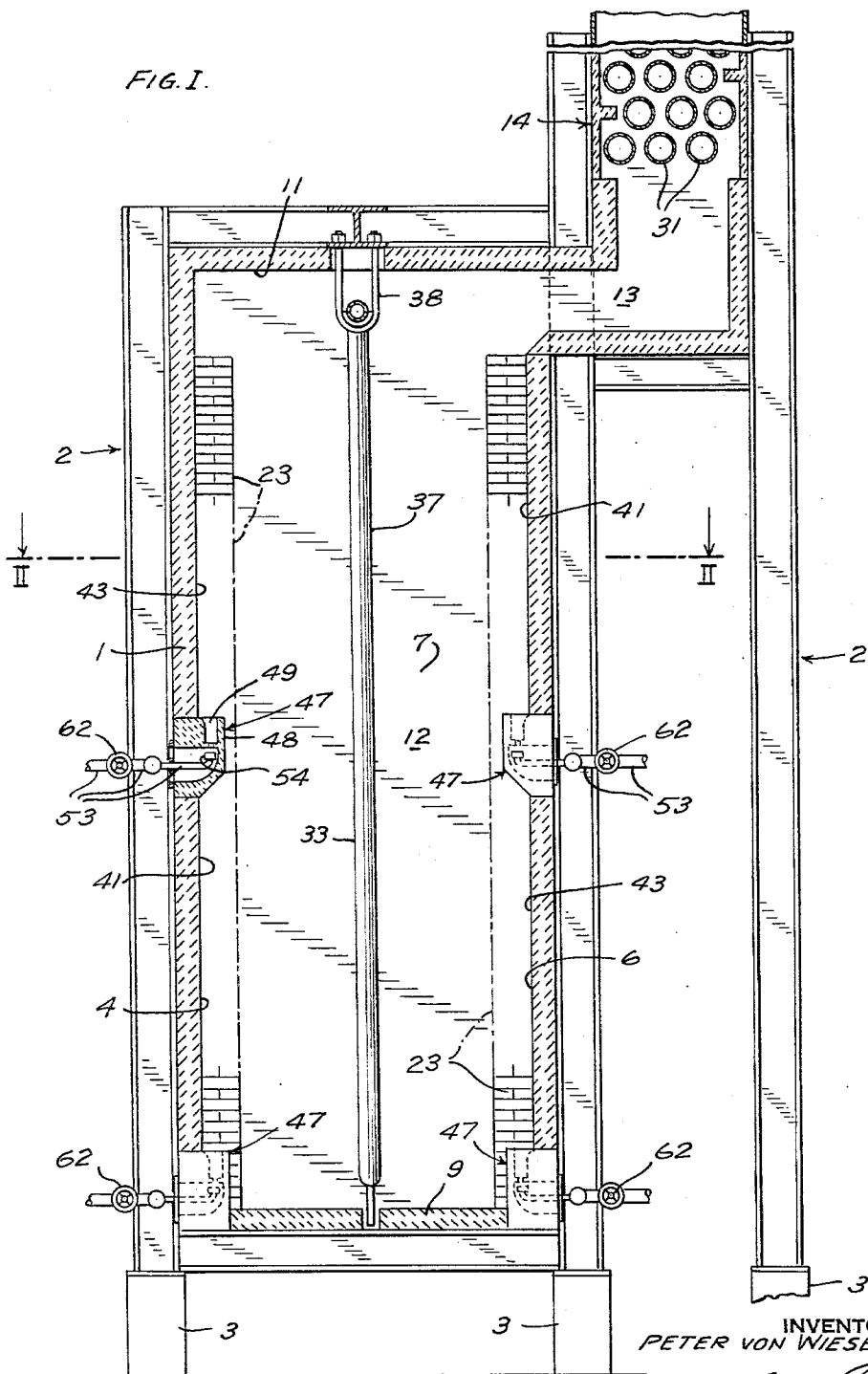
3,240,204

PYROLYSIS HEATER

Filed Feb. 19, 1964

2 Sheets-Sheet 1

FIG. I.



INVENTOR
PETER VON WIESENTHAL

BY *Charles E. Boley*
ATTORNEY

March 15, 1966

P. VON WIESENTHAL

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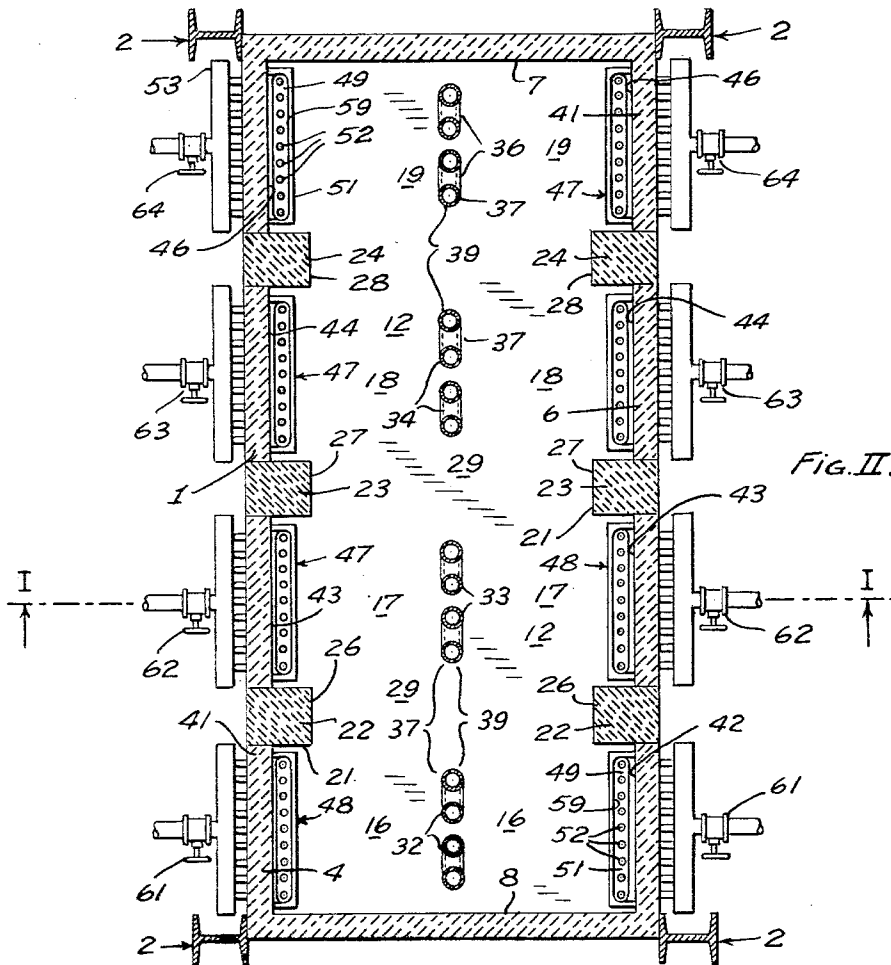


Fig. II.

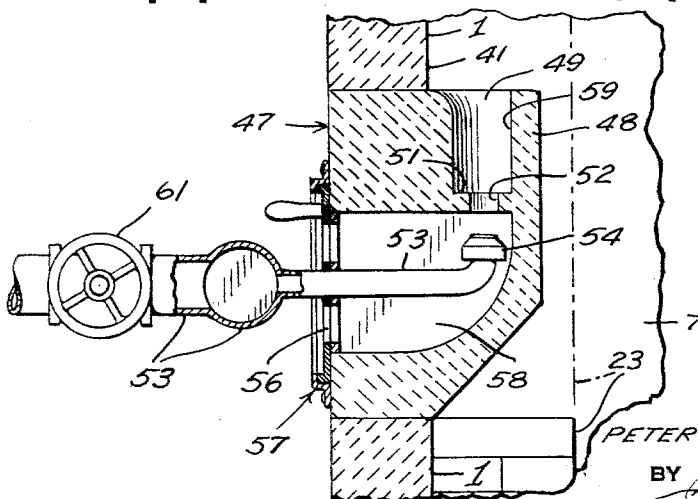


Fig. III.

INVENTOR
PETER VON WIESENTHAL

BY *Arthur E. Berly*
ATTORNEY

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3,240,204

PYROLYSIS HEATER

Peter von Wiesenhal, New York, N.Y., assignor to Alcorn Combustion Company, New York, N.Y., a corporation of Delaware

Filed Feb. 19, 1964, Ser. No. 345,889

2 Claims. (Cl. 126-109)

This disclosure relates to a direct-fired process heater. The invention contemplates an inexpensive arrangement which is especially suitable for hydrocarbon pyrolysis service.

Pyrolysis requires that relatively high temperatures be employed. For example, satisfactory ethane-to-ethylene pyrolysis usually calls for temperatures in the order of from 1500° to 1550° F. For satisfactory propane-to-propylene pyrolysis, the temperature range is from 1450° to 1500° F. The reactants and products are sensitive to the duration of their exposure to such high temperatures. Sensitivity of this sort generally manifests itself in side reactions producing unwanted byproducts which waste ingredients that could otherwise be recycled. Unwanted byproducts also aggravate product separations. But worse than this, these side reactions often cause coke deposition. By impeding the ability of reactants to remove heat from the tube metal, coke deposits hasten the burning through of tube walls.

To minimize side reactions, control of time-temperature relations is critical. It has been found that side reactions in pyrolysis heaters are minimal with a concave upward time-temperature curve which rises steeply toward the outlet.

Commercial attempts at achieving such a time-temperature curve have until now been frustrated. These attempts have generally included several radiant type burners (with or without radiant walls) disposed along the path of the process stream. Firing of the various burners was organized to coincide with the heat input desired along the way. But heat input is not easy to isolate. Carbon dioxide and water vapor in combustion gases also give off radiation. Varying radiant input caused temperature differences which occasioned thermal inversions. Stated somewhat differently, differences in the density of gases at various temperatures occasioned convection currents which restored a uniform temperature throughout the furnace. As a practical matter thermal inversions thoroughly failed control of the time-temperature relations.

The present advance achieves time-temperature control by a novel and facile arrangement. A heater is provided with a long chamber. Transverse vertical baffles divide the chamber into several zones along its length. A thermal inversion circuit of combustion gases is established in each zone with substantial independence from the thermal inversion circuits in the other zones.

It has been discovered that, with radiant walls and low-flame burner arrangements, the transverse baffles need not project into the chamber more than a relatively short distance (from one-tenth to one-fourth of the chamber width) in order to afford very adequate isolation of thermal inversion circuits in adjacent zones. By this teaching access to medial tube banks can be improved and materials can be saved.

Coursing a process stream in flow series through several adjacent zones involves a tube bank with a generally vertical serpentine configuration. When a single level of burners is employed, such a tube bank could be unduly expensive, so it is preferred that two levels of burners be used to heat the radiant walls. With two or more burner levels, very satisfactory tube lengths are reached.

These and other features will appear more fully from the accompanying drawings wherein:

FIGURE I is an elevation view (in section) of a crack-

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ing furnace according to this invention and taken along line I—I of FIGURE II.

FIGURE II is a plan view (in section) taken along line II—II of FIGURE I.

FIGURE III is a partial view in vertical section on an enlarged scale of the burners shown in FIGURES I and II.

In the drawings elongated setting 1 depends from structural frame 2 which transmits loads to piers 3. Setting 1 has first 4 and second 6 side walls, and end walls 7 and 8 as well as floor 9 and roof arch 11 defining chamber 12 therebetween. Chamber 12 communicates in flow series with a stack (not shown) via roof passage 13 and convection section 14.

Radiant heat input is to be divided into segments which are to be made independent of thermal inversions. Toward this objective radiation sources are arranged laterally relative to each other and the thermal inversion circuits naturally formed by each of these radiation sources are also isolated laterally relative each other. Thus each radiation source and its associated thermal inversion circuit is maintainable with substantial independence from the other circuits. To subdivide chamber 12 into first 16, second 17, third 18, and fourth 19 thermal inversion zones, vertical baffles 21 are grouped in opposed pairs 22, 23, and 24. Each of the baffles 21 of pairs 22, 23, and 24 is connected to one of the opposed side walls 4 or 6. Inward projections 26, 27, and 28 of baffle pairs 22, 23, and 24 respectively extend toward each other. With the shown arrangement, it is only necessary that inward projections 26, 27, and 28 extend from one-tenth to one-fourth of the width of chamber 12 in order to attain satisfactory isolation of thermal inversion circuits in zones 16, 17, 18, and 19. This leaves central passage 29 open for tube access.

The independent thermal inversion zones are arranged along the path of the process stream as it courses through the heater. After circulation through convection coil 31 for preheating, the process stream is communicated in flow series through first 32, second 33, third 34, and fourth 36 portions of tube banks 37 in that order. Tube bank 37 generally describes a vertical serpentine configuration suspended by means of straps 38 approximately midway between side walls 4 and 6. Loops 38 space first 32, second 33, third 34, and fourth 36 tube portions in thermal inversion zones 16, 17, 18, and 19 for greater independence of heat input to each portion.

It is desirable to introduce heat to both sides of tube bank 37. This technique is familiarly known as double firing. Both side walls 4 and 6 are lined with a high-temperature-resistant refractory material 41. Refractory 41 forms first 42, second 43, third 44, and fourth 46 pair of opposed radiation surfaces. These pair of radiation surfaces embrace first 32, second 33, third 34, and fourth 36 tube portions respectively. The four inversion zones shown in this embodiment permit a high degree of control over time-temperature relations. But it will be understood that more or less zones may be provided depending upon the economics of a particular design situation and the degree of control that is necessary.

Burners 47 are operatively associated with radiation surfaces 42, 43, 44, and 46 for heating these surfaces to incandescence. It is preferred that these burners produce low flames. Blocks 48 form troughs 49 with bottoms 51. Each bottom 51 defines a plurality of orifices 52 which communicate in flow series with their associated trough 49. Fuel is introduced via conduits 53 and nozzles 54 to orifices 52. Air enters by way of openings 56 in air registers 57 and air passages 58 so that the fuel burns in troughs 49 with a minimum of flame extending out of these troughs. The troughs are shown to be arranged

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along associated radiation surfaces for improved distribution of heat thereover. Steep inner lips 59 remote from the associated radiation surfaces shield tube bank 37 from direct flame impingement.

The heat output of each burner can be controlled by valves such as 61, 62, 63, and 64 using well known techniques.

It will be apparent to those skilled in fired heater design that wide changes may be made in the details of this disclosure without departing from the main theme of invention as outlined in the following claims.

What is claimed is:

1. A fired heater comprising

an elongated setting having opposed vertical planar side walls and opposed end walls all defining a chamber therebetween,

at least one pair of opposed transverse vertical baffles mounted in the chamber,

each of the baffles of a pair connected normal to opposed side walls and each baffle having an inward projection,

the inward projections of each pair of baffles extending from its associated side wall toward each other from one-tenth to one-fourth the width of the chamber to divide the chamber into at least a first inversion zone longitudinally disposed relative an adjacent second inversion zone so that thermal inversion circuits of combustion gases can be established in each of the zones with substantial independence from thermal inversion circuits in the other zone,

a planar tube bank describing a substantially vertical serpentine configuration and mounted approximately midway between the side walls,

the tube bank including a first and a second tube portion in the first and second inversion zones respectively,

means for circulating a process fluid in flow series through the first and second tube portions in that order,

both of the side walls lined with refractory to define a first and a second pair of opposed planar radiation surfaces with the first pair of radiation surfaces embracing the first tube portion and the second pair of radiation surfaces embracing the second tube portion, a first burner mounted in operative relationship relative each of the first radiation surfaces for heating

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the first radiation surfaces to incandescence whereby the first tube portion is double fired,

a second burner mounted in operative relationship relative each of the second radiation surfaces for heating the second radiation surfaces to incandescence whereby the second tube portion is double fired, first control means for regulating the heat output of the first burners,

second control means for regulating the heat output of the second burners,

a source of normally gaseous fuel,

each of the burners having a block which defines a horizontally elongated vertically opening trough with a bottom,

each of the troughs arranged below and along its associated radiation surface,

each of the bottoms defining a plurality of orifices communicating in flow series with its associated trough,

means for delivering the fuel and air to the troughs via the orifices so that the fuel burns in the troughs with a minimum of flame extending upward into the troughs,

each of the blocks defining a steep lip on the inside of the trough remote from the associated radiant surface and arranged to shield the tube bank from seeing radiation emitted directly from the flame in the trough.

2. The heater of claim 1 with at least two levels of burners operatively associated with at least one of the radiation surfaces so that relatively long tube lengths can be employed.

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CHARLES J. MYHRE, *Primary Examiner.*

JAMES W. WESTHAVER, *Assistant Examiner.*